



Woods Canyon Lake Fisheries Management Plan 2019-2029

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Approved by Chris Cantrell

D. Andrew Ch...
Aquatic Wildlife Branch Chief

Date

12/20/19

Location

Woods Canyon Lake is located on the boundary between game management units 4A and 4B in Coconino County at UTM Zone 12-NAD 83 505170E, 3799189N. The lake is located on the edge of the Mogollon Rim, approximately 33 miles east of Payson and 28 miles west of Heber-Overgaard on State Route 260. It is entirely on the Apache-Sitgreaves National Forests (Forest), and is one of several lakes collectively known as the Rim Lakes.

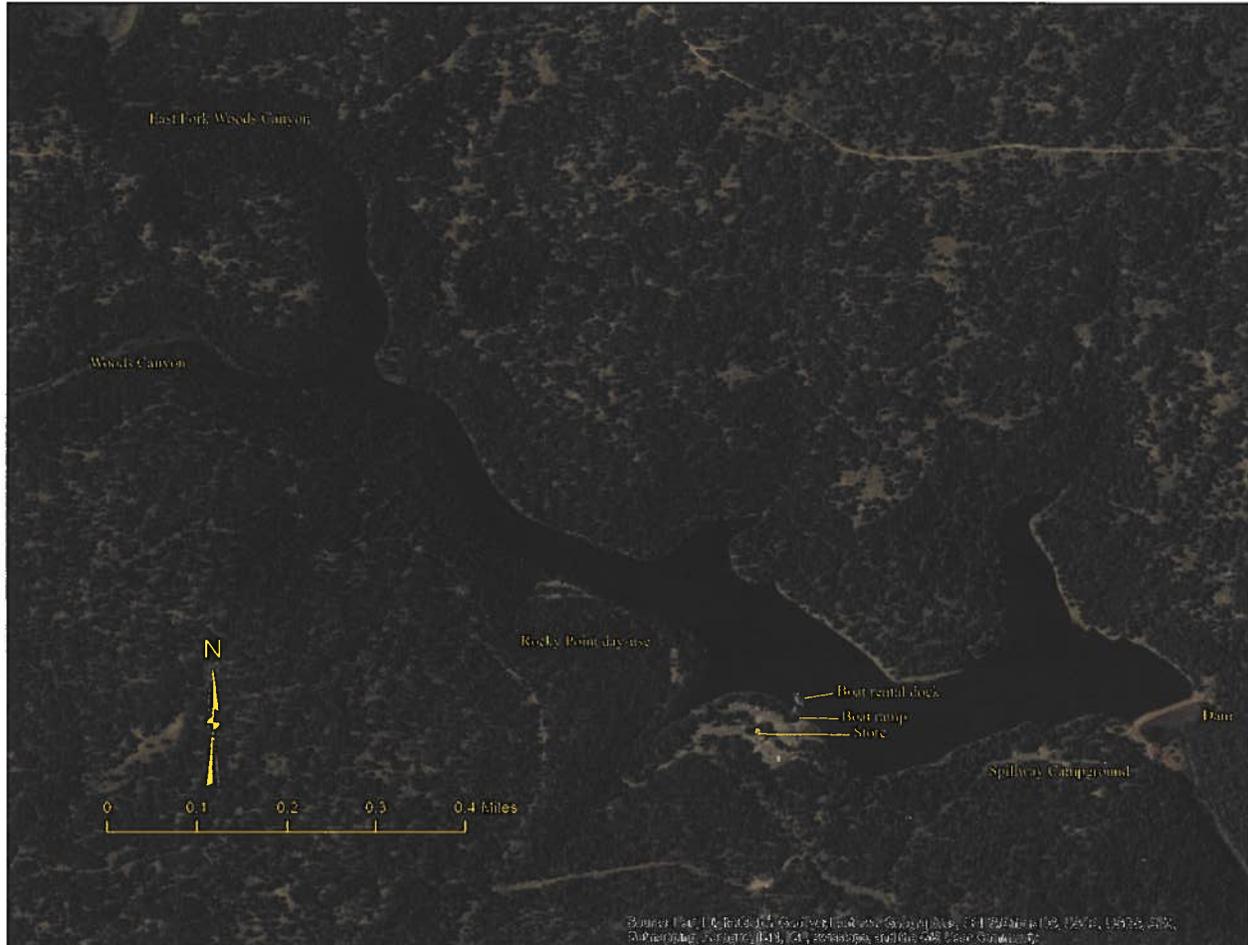


Figure 1. Map of Woods Canyon Lake, Coconino County, Arizona.

Management Prescription

The Arizona Game and Fish Department (Department) has developed approaches to guide coldwater species management under the Coldwater Sportfisheries Strategic Vision Document (AGFD 2019). The primary and only management emphasis for Woods Canyon Lake is for a coldwater sportfishery. The primary management approach is Intensive Use to be supported by frequent stocking of Rainbow Trout *Oncorhynchus mykiss*, and the secondary management approach is Featured Species to be supported by stocking Tiger Trout *Salmo trutta x Salvelinus fontinalis* annually (Young et al. 2001). The coldwater sportfishery emphasis is based on the following factors in order of priority:

1. The demand for coldwater angling at this lake and general area,
2. The presence of suitable coldwater habitat in the lake, and
3. The need for management to be compatible with downstream resources that include:
 - a. Wild Brown Trout *Salmo trutta* and Brook Trout *Salvelinus fontinalis* fishery in Woods Canyon Creek,
 - b. Wild Blue Ribbon Brown Trout fishery in upper Chevelon Canyon Creek,
 - c. Quality stocked Rainbow Trout and wild Brown Trout fishery in Chevelon Canyon Lake, and
 - d. Native fish populations in Chevelon Canyon Creek that include Little Colorado Spinedace *Lepidomeda vittata* (Threatened), Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus* and Little Colorado Sucker *Catostomus sp.* (Conservation Agreement species), and Speckled Dace *Rhinichthys osculus*.

Objective 1: Maintain the Rainbow Trout population to meet or exceed Intensive Use standards.

Objective 2: Maintain the Tiger Trout population to meet or exceed Featured Species standards.

Objective 3: Maintain angler satisfaction at 80%.

The Department has been approved to stock Rainbow Trout into Woods Canyon Lake, and recently gained approval to also stock Tiger Trout. Management strategies, including gillnetting surveys, angler creel surveys, and non-native species removal, for meeting Objectives are listed in Table 1.

Table 1. Woods Canyon Lake Objectives and Adaptive Management Strategies:

<i>Objective 1: Maintain the Rainbow Trout population to meet or exceed Intensive Use standards as listed in the Coldwater Sportfisheries Strategic Vision Document.</i>			
Parameters	Objective Guideline	Trigger point to address unmet objectives	Strategies if objectives are not met
Angler Catch Rates	Maintain catch rate of 0.5 fish per hour during stocking season.	Angler catch rates drop below 0.5 fish per hour for two consecutive creel surveys.	<ul style="list-style-type: none"> • Stock larger Rainbow Trout • Regulation changes
<i>Objective 2: Maintain the Tiger Trout population to meet or exceed Featured Species standards as listed in the Coldwater Sportfisheries Strategic Vision Document.</i>			
Angler Catch Rates	Maintain catch rate of 0.5 fish per hour during stocking season.	Angler catch rates drop below 0.5 fish per hour for two consecutive creel surveys.	<ul style="list-style-type: none"> • Stock larger Tiger Trout • Outreach/education • Regulation changes
Tiger Trout persistence	Multiple age classes of Tiger Trout are caught by anglers.	Tiger Trout caught by anglers are only from that years stocking.	<ul style="list-style-type: none"> • Stock larger Tiger Trout • Outreach/education • Regulation changes
<i>Objective 3: Maintain angler satisfaction at 80%.</i>			
Angler Satisfaction	Angler satisfaction in creel surveys >80%.	Angler satisfaction drops below 80% for two consecutive creel surveys.	<ul style="list-style-type: none"> • Stock 10-inch minimum Rainbow Trout • Stock 1 pound fish (1 NPP) minimum • Stock more or larger Tiger Trout • Improve access conditions

Background

Woods Canyon Lake is an artificial reservoir constructed by the Department in 1956 for aquatic recreation. The lake was created by constructing a dam on Woods Canyon Creek in the headwaters of the Chevelon Canyon Creek watershed in the Little Colorado River basin, at an elevation of 7,505 feet.

The lake is 55 surface acres in size, with an average depth of 25 feet and a maximum depth of 40 feet. The Department has management and maintenance authority for the dam through a Special Use Permit with the Apache-Sitgreaves National Forests (Forest). The Department also owns the water rights for 1,013.8 acre-feet of storage within Woods Canyon Lake for aquatic recreation with a priority date of March 29, 1954. The water right does not allow for managed releases downstream.

Woods Canyon Lake has a relatively small watershed, draining approximately 9.12 square miles (5,836 acres) of mixed conifer forest. Woods Canyon Creek and East Fork Woods Canyon Creek drain into the lake (Figure 1), but neither is perennial, running ephemerally during snowmelt runoff and occasionally following locally heavy summer rains. The lake level is maintained naturally through winter snowmelt, with little influence from summer rainfall.

Woods Canyon Creek located downstream of the lake is perennial for most of its 5.2 mile (9.2 kilometer) course before joining with Willow Springs Creek to form Chevelon Canyon Creek (Lopez et al. 1998a). Chevelon Canyon Creek flows perennially for 10.8 miles (17.4 kilometers) to Chevelon Canyon Lake, then with mixed flows downstream of Chevelon Canyon Lake for 68.5 miles (110.2 kilometers) to the confluence with the Little Colorado River (Lopez et al. 1998b).

Current angling regulations fall under the statewide regulations for gear and bag limits for trout, which allow bait, lures, flies, including treble hooks, and a 6 trout (in aggregate, not per species) daily bag limit. Bag limits are unlimited for bass and catfish to emphasize the management focus on a coldwater fishery for trout and discourage illegal fish introductions. The use of live baitfish is not permitted at Woods Canyon Lake, nor is it permitted in all of Coconino, Navajo, Apache, Pima, and Cochise counties.

Productivity/Water Quality

Water quality is good for trout at Woods Canyon Lake. Water temperatures, pH levels, and dissolved oxygen (DO) are good year-round, allowing trout stocking from the time it is accessible in the spring (usually early to mid-April) into late September when the angler use declines.

The lake ices over in the winter, generally from December into early April. Once the ice melts off the lake in the spring, water temperatures, pH, and DO are very good and fairly consistent throughout the entire water column. A drop in oxygen occurs below the thermocline which develops in the summer as surface water temperatures increase. The drop in oxygen starts at about 9 meters (30 feet) below the surface in May. The thermocline then fluctuates to 5 meters (16 feet) in June and July, 4 meters (13 feet) in August, 5 meters in September, 6.5 meters (21 feet) in October, then breaks up by November, as measured during an intensive limnological survey by Department Regional biologists in 2003 and 2004 (Table 2). Very good conditions are again consistent through the entire water column in late fall and winter. Colder water temperatures exist below the thermocline in the summer, but the water is anoxic (no oxygen) due to a lack of mixing below the thermocline and lack of oxygen production at those depths. Thus, trout are only able to go as deep as the thermocline level when seeking colder water during the summer months and congregate in a very narrow layer in and around the thermocline.

pH levels are consistently good at Woods Canyon Lake, not exceeding 7.3 during the summer months. Conductivity is low, ranging from about 20-35 umhos through most of the water column throughout the year. Turbidity is generally low, resulting in fairly clear water, with Nephelometric Turbidity Units (NTU) measurements in single digits most months, but spiked up to 20-35 in August, September, and October in 2003. The only other water quality concern was moderately low DO (5.8-5.9 mg/l) in the top layers of water (above the thermocline) in August, September, and October in 2003. These levels were beginning to become marginal, but still suitable for trout since they did not drop below 5 mg/l above the thermocline. These near marginal DO levels above the thermocline in late summer/early fall were not observed during surveys in 2002 and 2004, when DO levels were consistently above 6 mg/l.

No fish kills due to water quality, have been documented at Woods Canyon Lake, even during the winter under substantial ice cover.

Productivity in Woods Canyon Lake is low (Meyer et al. 2005). Limnological surveys conducted by Department biologists in 2002-2004 found ammonia, nitrites, nitrates, and total phosphorus to be below detection limits on nearly all survey trips. Total nitrogen was within detection limits, but were relatively low on all dates surveyed (<0.50 mg/l). Chlorophyll A and total dissolved solids were also low, measuring <4.5 ug/l and <30 mg/l, respectively, on nearly all survey trips. The extremely low level of total phosphorus is likely the main limiting nutrient in the system. Low levels of nutrients, particularly phosphorus, lead to low primary productivity (inadequate prey sources) and poor trout growth. Woods Canyon Lake is better suited for stocking catchable size fish to be caught immediately rather than stocking smaller size class fish which are intended to grow in the lake.

This low productivity is due to the sandstone geology, which is extremely insoluble, and the small watershed at Woods Canyon Lake (Ercole 1968). The low productivity has existed since the lake was constructed in 1956. A project was conducted by the Department in 1966-1970 in an effort to increase the productivity of Woods Canyon Lake by adding commercial fertilizers (Kemmerer 1967; Ercole 1968; Ercole 1969; Ercole 1970; and Ginnelly 1971). The project was initially successful in increasing nutrient levels and primary productivity with certain mixtures of fertilizers, but these increases declined throughout the project even as they added more nutrients, and did not increase production of trout as expected. One of the reasons why the increase in trout production was low was due to an expanding population of Golden Shiner *Notemigonus crysoleucas* that benefitted from the productivity and competed directly with trout for food resources (zooplankton). The project was abandoned when the Golden Shiner population reached significant levels and trout growth continued to decrease. This has led to the lake being managed primarily as a put-and-take fishery since then, with only minor stockings of fingerling trout from 1970 to the year 2000. Today the lake is stocked only with catchable size trout. A recent illegal introduction of Green Sunfish *Lepomis cyanellus*, which prefer the same zooplankton and invertebrates as trout, further detracts from the benefits of fertilizer addition.

The low productivity of the lake continues to influence the fishery, even when stocking only catchable size trout. Although the stocked trout are not expected to grow in the lake after stocking,

their condition generally decreases through the fishing season after they are stocked (Meyer and Dreyer 2012), negatively influencing the length of time they persist in the lake. High harvest rates at Woods Canyon Lake likely mask this potential issue. The exception is a slight increase in condition of carryover trout early in the spring (see Forage/Prey below). Although artificial fertilization of the lake failed in the 1960s-1970s, new ways to increase productivity should be analyzed. A study of current productivity in Woods Canyon Lake is needed.

Forage/Prey

Forage for trout in Woods Canyon Lake consists of zooplankton, benthos invertebrates (including crayfish), aquatic and terrestrial insects, and small fish species.

Zooplankton were surveyed in Woods Canyon Lake by Department Regional biologists in 2003, as reported by Meyer et al. (2005). This zooplankton survey found relatively low densities of zooplankton available to trout. Generally, only the larger zooplankton in the Cladocera group (primarily *Daphnia*) are large enough to contribute significantly to the diet of a catchable size trout, however the densities of Cladocera in Woods Canyon Lake were low, with a moderate spike of 60 individuals per plankton tow in July and a smaller spike of 31 per tow in October (Figure 2). All other months averaged below 30 Cladocera per tow. Rotifers were fairly numerous in April, May, and June, but are generally too small to sustain adult trout. Copepods, which are usually moderate in size between rotifers and Cladocera, had low densities all year.

Benthos invertebrates in Woods Canyon Lake were also surveyed by Department Regional biologists in 2003, both in the littoral zone (near shore) and hypolimnetic zone (deep sections that fall below the thermocline in the summer) (Meyer et al. 2005). Chironomid midge larvae and Chaoborus (phantom midge) larvae were the most abundant benthos invertebrates throughout the year in both the littoral zone and hypolimnetic zone, although oligochaetes (a group of segmented worms) had a small spike in the littoral zone in the fall only (Figure 3). Chironomids were very abundant in the littoral zone in the fall, with an average of 1,333 chironomids per dredge sample. Benthos invertebrates in the hypolimnetic zone become unavailable to trout when the lake stratifies in May through October, except when they migrate to the upper layers to feed at night (Chaoborus) or to hatch into adults (Chironomids and Chaoborus).

Woods Canyon Lake currently has an abundance of small bodied forage fishes, including Green Sunfish, Fathead Minnow *Pimephales promelas*, and Golden Shiner. Green Sunfish were by far the most abundant forage fish caught during boat electrofishing surveys in 2014, 2015 and 2016, with Fathead Minnow next abundant, and Golden Shiner uncommon in the catch (Figure 4). Fathead Minnow and Golden Shiner may be under represented in these surveys because Green Sunfish are more easily caught with this survey gear along the shoreline at night than Fathead Minnow of which many are too small to capture with boat electrofishing, or Golden Shiner, which tend to migrate to the limnetic zone at night (Hall et al. 1979) and out of the range of this survey gear. Golden Shiner have been known to overpopulate in Woods Canyon Lake and compete with trout for zooplankton forage. Threadfin Shad *Dorosoma petenense* were stocked into Woods Canyon Lake in 1961 as an experimental forage fish, but was unsuccessful (Bruce 1961). Reproduction of shad was documented in the first year, but the species did not persist and there was little predation by trout when shad were present.

The addition of new forage fishes into Woods Canyon Lake is not recommended since Rainbow Trout would likely not utilize them anyway and abundant forage species exist to support Tiger Trout.

A diet study was conducted on Rainbow Trout in Woods Canyon Lake in 2003 by Department Regional biologists (Meyer et al. 2005). Rainbow Trout caught in April represented stocked fish that had carried over from the previous year and had the greatest variety in their stomach contents. Over 80% of spring Rainbow Trout contained Dipterans (true flies), 35% contained Coleopterans (beetles), 19% contained crayfish, and 8% (n=2) contained fish remains (Figure 5). Other items found in stomachs included: plant material (19%), rocks (4%), and rubber/artificial worms (15%) discarded or lost by anglers. These trout had survived from the previous year likely because they had learned to feed on available forage. Only 4% of carryover trout (n=1) had an empty stomach. However, relatively few trout carry over through the winter, with an estimated 1,777 Rainbow Trout overwintering in Woods Canyon Lake in a mark recapture study ending in the spring of 2011.

Of the Rainbow Trout caught in July 2003, 60% had empty stomachs, 10% (n=1) had Dipterans, and 20% (n=2) had fish remains. Of the Rainbow Trout caught in November, 43% had empty stomachs and 21% had crayfish. Other stomachs had indigestible plant material or rocks. The Rainbow Trout sampled in July and November were representative of trout that were recently stocked, most of which were not eating well.

Six Brown Trout were also captured in April 2003 and were included in the diet study. All (100%) had crayfish in their stomachs, while 33% also had fish remains. These Brown Trout were all large (18.5-21 inches long) and did not appear to be feeding on smaller food items that dominated the Rainbow Trout diet at the same time of year. Brown Trout are no longer approved for stocking in Woods Canyon Lake and are now rare in the lake, but the current addition of Tiger Trout will hopefully better utilize the crayfish and forage fish available than Rainbow Trout. Duplication of this diet study may help assess changes to available forage, ability of hatchery trout to adapt to wild prey items, and success of Tiger Trout as piscivorous predators.

Habitat

Lake bathymetry and available aquatic habitat was surveyed in 2015 by the Aquatic Habitat Program (Figure 6; Figure 7). There is little fish habitat in Woods Canyon Lake except for a rocky shoreline and a few submerged stumps in the very upper end. There are few to no aquatic plants growing in the lake.

Trout are not known to require structural habitat to do well, therefore, habitat is not considered to be a limiting factor in Woods Canyon Lake. Non-desirable species such as bass and Green Sunfish benefit from aquatic habitat structures, so it is not recommended that any structures be added to Woods Canyon Lake.

Species

Current fish composition in the lake consists of stocked Rainbow Trout and Tiger Trout, illegally introduced Green Sunfish and Golden Shiner, and established Fathead Minnow. Brown Trout are rarely encountered, and are remnants of historical stockings as recent as 1995. Brook Trout and Cutthroat Trout were also historically stocked up to 1995, but did not persist in the lake. Coho Salmon were stocked in 1972-1973, but also did not persist. The only fish species other than trout and salmon that have been legally stocked into Woods Canyon Lake since its construction in 1956 was Threadfin Shad in 1961. Goldfish and bass have been reported in Woods Canyon Lake but have not been confirmed by fish population surveys. The presence of these species would be the result of illegal stockings. Woods Canyon Lake is prioritized as a Tier III fishery, requiring a minimum of one fish population survey every 10 years because it is primarily a put-and-take trout fishery with no natural reproduction and little carryover from previous stocking years. Gillnetting is the standard survey method for trout, but may incidentally capture sunfish, minnows or Golden Shiner (AGFD 2004). The illegal stocking of warmwater species would have the greatest impact on the Rainbow Trout fishery, thus boat electrofishing surveys are recommended periodically to detect undesirable species before they establish reproducing populations. Boat electrofishing will provide information needed to accurately assess warmwater species composition, detect illegal fish introductions, and may be beneficial to survey Tiger Trout which are difficult to capture in gill nets. Warmwater species-focused electrofishing surveys were conducted in November 2014, September 2015 and October 2016 and detected Green Sunfish, Fathead Minnow and Golden Shiner, as well as Rainbow Trout and Tiger Trout (Figure 4). No bass were detected. Management actions to reduce or remove undesirable species from Woods Canyon Lake may be required as those populations increase, particularly if trout growth and condition are shown to decrease in response.

Rainbow Trout:

Catchable size Rainbow Trout are stocked every week from mid-April through the end of September during Woods Canyon Lake's highest angler use months. Rainbow Trout have been stocked at a rate of approximately 20 pounds per acre each week, though that number could be reduced if larger trout are available from Department hatcheries. Stocked rainbows typically average 2.5 fish per pound (0.4 pounds each) and are no less than 9 inches in length. It is recommended to increase the size of Rainbow Trout stocked, and the Regional Program will begin requesting fish at 1.7 to 2.0 fish per pound. Stocking shall occur late in the week to maximize the weekend angling success. Trout do not reproduce in the lake, which is consistent with other trout lakes in Arizona, requiring regular stockings to maintain the sportfishery. Little growth is observed in trout, once stocked, and the majority of fish are caught out during the stocking season and do not overwinter. The most recent regular gillnetting survey was conducted in 2010 and sampled 57 Rainbow Trout, ranging in size from 10.1 to 16.4 inches. After Tiger Trout were stocked in 2016, several additional surveys were conducted to assess survival and growth. The most recent supplemental gillnetting survey was conducted in April 2017 and found 84 Rainbow Trout, ranging in size from 8.1 to 13.5 inches with a relative weight (Wr) of 69.1 on average. Relative weight values around 100 represent an average, healthy fish, with values below 100 indicating poor body condition and values above indicating excellent, overweight fish.

Tiger Trout:

Experimental, catchable size Tiger Trout stocking in Woods Canyon Lake began in May 2016 to increase the diversity of angling opportunity, and hopefully to help control the abundant sunfish, shiners, and Fathead Minnows. Tiger Trout are currently stocked twice during spring or early summer at a rate of approximately 35-40 pounds per acre, with a minimum length of 8.5 inches. While the piscivory of Tiger Trout is still being evaluated, anecdotal reports are that anglers are happy with the new fishing opportunity. Creel surveys should be conducted in order to support this additional stocking long term. The stocking prescription will be adjusted as necessary after this study is completed.

Tiger Trout survival and growth were most recently surveyed using gillnets in April 2017. During this assessment, 69 Tiger Trout were sampled, ranging in size from 8.2 to 13.4 inches, with an average relative weight of 72.4. In March 2017, Department biologists weighed and measured Tiger Trout at the hatchery prior to stocking. Average Wr prior to stocking was 91.2. Tiger Trout were surveyed in September 2017 by boat electrofishing. Average Wr found in that survey was 73.0. Tiger Trout had the highest Wr while in the hatchery and survey results found body condition decreased substantially while in the lake, and was worst after winter. Poor body condition after stocking suggests Tiger Trout may not be keying in on prey sources efficiently, especially after winter when insects, crayfish and fish prey may be less active and/or unavailable. Low growth and weight loss after stocking further supports the need to stock only 8.5 inches or larger trout to maintain angler satisfaction. Diet studies may help determine what Tiger Trout are consuming in Woods Canyon Lake, but will not help increase Wr of fish which are unable to find appropriate prey sources. Competition with illegally introduced and undesirable fish may also be having a negative impact on Tiger Trout.

Invasive Species

There are no records of aquatic invasive species at Woods Canyon Lake.

The lake does contain illegally introduced Green Sunfish and Golden Shiner, which are not invasive species, but are undesirable for this lake. Reports of Goldfish and bass, also considered undesirable for this lake, have not been confirmed despite recent fish population surveys. The risk of illegal introduction of other warmwater species is high because of the lake's proximity to other Rim Lakes that have confirmed illegal introductions of other undesirable species for these lakes (Smallmouth Bass *Micropterus dolomieu*, Largemouth Bass *Micropterus salmoides*, Black Crappie *Pomoxis nigromaculatus*, Green Sunfish, and White Sucker *Catostomus commersonii* in Willow Springs Lake; Largemouth Bass and Green Sunfish in Black Canyon Lake; Yellow Bullhead *Ameiurus natalis*, Green Sunfish, and Largemouth Bass in Blue Ridge Reservoir; and Largemouth Bass, Bluegill, and Golden Shiner in Long Tom Tank).

Green Sunfish, Golden Shiner, and Fathead Minnow reproduce well in the lake. Golden Shiner had been known to overpopulate in Woods Canyon Lake and compete directly with stocked trout, and the Department has twice taken actions to eliminate them in the past. The lake was chemically treated with rotenone in September 1965 to eradicate Golden Shiner, which was unsuccessful. The lake was drained in 1975 and the remaining small pool of water was treated with rotenone in September 1975 again to eradicate Golden Shiner, which was considered successful (Stone 1976). They reappeared in 1980 despite live baitfish being prohibited in this area.

Woods Canyon Lake has an abundant population of Northern Crayfish *Orconectes virilis*, which are not native to Arizona. Densities of crayfish ranged from an average of 11.7 crayfish per overnight trap in 2004 to an average of 22.0 crayfish per trap in 2003, when surveyed by Department Regional biologists (Meyer et al. 2005).

Access

Access to Woods Canyon Lake is via paved surfaces of Forest Road 105 from the Rim Road (Forest Road 300) as it runs north from Highway 260 along the scenic Mogollon Rim. There is one boat ramp located on the south shore near the Woods Canyon Lake store and concession. Boats are restricted to electric only motors because of the high angler use, small size of the lake, and proximity to campgrounds. Boat rentals are available, with a private boat-rental dock adjacent to the boat ramp.

Access to fishing along the shoreline is good on the south side and dam, since the paved roads to the boat ramp, Spillway Campground, and Rocky Point day-use area are all on the south side of the lake. Access to fishing along the north shoreline is unrestricted to foot and boat traffic, but difficult to get to unless anglers have a boat or are able to walk around the lake. The shorelines are mostly rocky and often steep, with few spots of flat and easy access.

The Spillway Campground has 26 sites, which are extremely popular and fill quickly due to its close proximity to the shoreline. Two other campgrounds are located along Forest Road 105 a short distance from the lake, including Aspen Campground with 136 sites and Crook Campground with 26 sites for group camping. The concession is privately owned, and the campgrounds are also managed by concession by Recreation Resource Management.

The lake is generally accessible from April through December, with Forest roads in the area usually closed during the winter due to snow. The lake ices over for 3-4 months during the winter about the same time the roads are closed.

Regulatory and informational signs at the lake are needed regarding fishing regulations, including species present and bag limits. Signs regarding the prohibition of live bait fish are recommended given the novel baitfish species which have been introduced to Woods Canyon Lake in recent years. Much of the shoreline is used for angling around Spillway Campground, in front of the boat launch, near Rocky Point Recreation area and along well-used trails which follow the shoreline toward the inflow to the lake along Woods Canyon Creek and East Fork Woods Canyon Lake / East Fork Woods Canyon Creek areas. Numerous signs may be required at these popular points to inform the maximum number of anglers.

Challenges in access include crowded shorelines, crowded boats on the lake during busy weekends, increasing use of non-motorized kayaks, paddleboards, and canoes, many who aren't fishing and often occupy the single boat ramp, few spots of flat easily accessible shoreline and no ADA shoreline access, no public dock to assist boaters with launching boats, annual seasonal closure of a section of shoreline for nesting Bald Eagles, deteriorating access roads, and minimal parking near the lake.

Access strategies for addressing these issues include maintaining electric-only motor restriction to maintain safe boating conditions during crowded periods, installing a ramp or beach for launching non-motorized craft that is separate, but possibly adjacent to the paved boat ramp, installing an ADA accessible fishing pier, jetty, or shoreline access, installing a public boat dock at the boat ramp, working with the Forest and Bald Eagle program on closure strategies that minimize impacts to anglers while protecting the needs of nesting Bald Eagles, and supporting Forest plans to improve access roads and increase parking at Woods Canyon Lake.

Road improvements occurred during April and May of 2019, but work was limited by snow and wet construction conditions, which delayed completion and impacted both stocking and angler access. Improved coordination with the Forest regarding future construction would help minimize difficulty scheduling early stocking events and allow better information dissemination to anglers and boaters.

Catch

Target overall angler catch rate at Woods Canyon Lake is 0.50 fish per hour (fish/hour) or greater during the stocking season from April through September, and an angler satisfaction rate of at least 80% fair, good or excellent.

Angler catch rates at Woods Canyon Lake are good, with an overall catch rate of 0.60 fish/hour from April through November, as determined by angler creel surveys in 2011 (Figure 8), exceeding the overall target catch rate. Catch rates were generally similar for bank anglers (0.60 fish/hour) and boat anglers (0.61 fish/hour) over the fishing season. August was the only month that fell significantly below the 0.50 fish/hour target, with a catch rate of 0.37 fish/hour for both bank and boat anglers combined. This is attributed to the habits of stocked trout in the heat of the summer. Water temperatures peak in Woods Canyon Lake in August, driving trout into deeper water in search of colder water temperatures. However, the lake is stratified at that time, with the thermocline about 4 meters below the surface with anoxic water below the thermocline (Table 2). Thus, the trout position themselves in a narrow layer of water just at the thermocline, where the temperatures are as cool as they can find that still have sufficient oxygen. This makes it difficult for anglers to find them, even though there are plenty of trout in the lake at that time. Catch rates in April were just under the target at 0.45 fish/hour and the bank fishing in November was down, at 0.33 fish/hour, though overall catch rates were above target at 0.77 fish/hour.

Over 88,000 Rainbow Trout were caught and over 50,000 were harvested at Woods Canyon Lake in 2011 (Figure 9). June and July are the peak catch and harvest months, which match the peak angler use. April and November have relatively low catch per unit effort (CPUE), catch, and harvest numbers, due to falling outside of the trout stocking season. August has low CPUE, catch, and harvest numbers due primarily to warmer water temperatures and the shallow thermocline.

Over 37,000 trout were caught and released in Woods Canyon Lake in 2011. Normally this would be a positive aspect of angling, as it should leave more fish in the lake for all anglers to catch repeatedly. However, most of these released fish (74%) were caught with bait, which is known to have a relatively high mortality rate on trout, depending on where the trout were hooked and how the trout were handled. Assuming that bait fishing leads to 50% mortality in released trout, almost

14,000 would die per year from bait without being harvested (Figure 10). It is difficult to change behaviors in anglers without regulations, but some education may lead anglers to switch to lures or flies if they want to catch-and-release or lead to more harvest of bait-caught fish. As most anglers likely purchase live bait (nightcrawlers) at the concessionaire on site, coordination with the store and informational signs may help guide anglers toward the appropriate gear for their harvest goals. Special regulations to address this issue are not desirable and not recommended.

Angler use peaks in June and July, with 42,435 and 37,275 angler hours per month, respectively (Figure 11). The use is overwhelmingly bank anglers, with 70% of anglers overall fishing from the bank. Total angler use at Woods Canyon Lake was 154,297 angler days in 2013, as reported in a Statewide angler use survey, ranking as the second highest use lake in Region I, with only Big Lake receiving higher angler use.

Satisfaction

Under the current management plan, angler satisfaction rates at Woods Canyon Lake are to be greater than 80%. During the last creel census conducted in 2011, satisfaction rates did not meet the target rate of 80% rating fair, good or excellent overall, though satisfaction was over 80% in July when stocking rates are highest (Figure 12). Satisfaction rated 64% fair/good/excellent overall. The lowest satisfaction rates occurred in April (59%), August (56%), and November (36%). This low satisfaction is primarily attributed to lower catch rates in those months (bank anglers only in November). Low catch rates in April and November were likely due to being outside of the stocking season. Much of the fishing in April occurred prior to the first stocking (April 21, 2011) and the last stocking on September 26, 2011 likely only supported decent fishing through October, resulting in poorer fishing in November, at least from the shore. Low satisfaction in August may be due to many potential factors, including heavy angler and recreational use, lower catch rates due to increased angler competition, low catch rates during the warmest time of the year when trout may be less active, or poor skill by novice or infrequent anglers. 2011 creel surveys suggest low catch rates may be the cause of low satisfaction (Figure 9). Further creel surveys with more specific questions may help pinpoint low satisfaction during stocking season or what management actions may improve satisfaction when catch rates are lower.

Overall satisfaction was close to 80% in several months, including May (70%), June (75%) and October (71%). These early and late season months tend to be when fishing pressure is lowest, weather is mild, angler and recreational use is moderate, and trout are still very active, all of which likely influence higher satisfaction rates. Since this creel census in 2011, Tiger Trout are being stocked annually in Woods Canyon Lake. Another creel census may show higher satisfaction rates given this new trout, which provides a different angling opportunity.

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Table 2. Water quality profiles for temperature (°C), pH, and dissolved oxygen (DO in mg/l) by month in Woods Canyon Lake, Arizona, when measured in a limnological survey in April – November 2003 and January 2004. The red shaded areas highlights very low DO levels in the bottom layers in the summer that are lethal, or near lethal, to trout.

Depth Meters	April			May			June			July			August		
	Temp	pH	DO	Temp	pH	DO									
S	9.16	6.89	9.15	17.79	8.35	7.31	19.86	7.43	6.73	22.48	7.04	6.49	22.48	7.23	5.88
1	8.56	6.78	9.29	17.67	7.98	7.30	19.41	7.44	6.73	22.13	7.06	6.60	22.38	7.20	5.82
2	7.75	6.79	9.37	17.18	7.89	7.31	19.29	7.41	6.70	21.40	7.01	6.53	21.71	7.23	5.84
3	7.58	6.81	9.26	15.34	7.86	7.35	16.67	7.25	7.85	20.95	6.87	6.51	21.07	7.19	5.81
4	6.81	6.78	9.35	13.55	7.84	7.78	13.40	6.72	7.66	19.16	6.43	5.89	19.32	6.65	3.92
5	6.21	6.74	9.28	11.38	7.82	7.82	10.51	6.27	5.33	16.67	5.96	4.51	16.66	6.31	1.35
6	5.99	6.71	9.12	9.40	7.77	7.64	8.33	6.09	2.75	13.39	5.64	2.10	11.64	6.16	0.14
7	5.86	6.66	9.05	8.23	7.70	7.20	7.12	6.07	0.57	10.12	5.61	0.49	9.43	6.18	0.04
8	5.56	6.62	8.88	7.28	7.65	6.45	6.87	6.13	0.29	8.09	5.78	0.35	8.34	6.26	0.03
9	5.32	6.58	8.63	6.33	7.56	4.12	6.63	6.15	0.20	7.55	5.86	0.32			
10	5.23	6.54	8.30	6.15	7.49	2.28				7.20	5.99	0.29			
11				5.97	7.18	0.25									

Depth Meters	September			October			November			January 2004		
	Temp	pH	DO	Temp	pH	DO	Temp	pH	DO	Temp	pH	DO
S	18.75	7.11	5.90	16.03	7.11	5.88	9.38	7.31	6.77	3.07	7.80	8.00
1	18.08	7.09	5.91	15.29	7.14	5.94	9.16	7.04	6.71	3.94	7.50	7.50
2	17.90	7.09	5.83	15.14	7.21	5.95	9.02	6.91	6.67	3.95	7.20	7.40
3	17.84	7.04	5.82	15.05	7.21	5.79	8.98	6.81	6.62	3.94	7.10	7.40
4	17.79	7.00	5.70	15.00	7.15	5.39	8.94	6.75	6.55	3.94	7.09	7.37
5	17.56	6.74	4.29	15.00	7.15	5.45	8.92	6.74	6.52	3.94	7.05	7.39
6	14.24	6.29	0.36	14.95	6.96	4.85	8.91	6.70	6.44	3.94	7.00	7.37
7	10.58	6.23	0.07	13.75	6.83	1.03	8.91	6.73	6.46	3.94	7.00	7.38
8	8.74	6.19	0.06	11.41	6.96	0.49	8.90	6.70	6.40	4.05	6.92	5.66
9	8.18	6.23	0.04	9.13	7.07	0.37	8.88	6.70	6.40	4.05	6.76	5.50
10	7.84	6.26	0.03				8.85	6.65	6.27			
11												

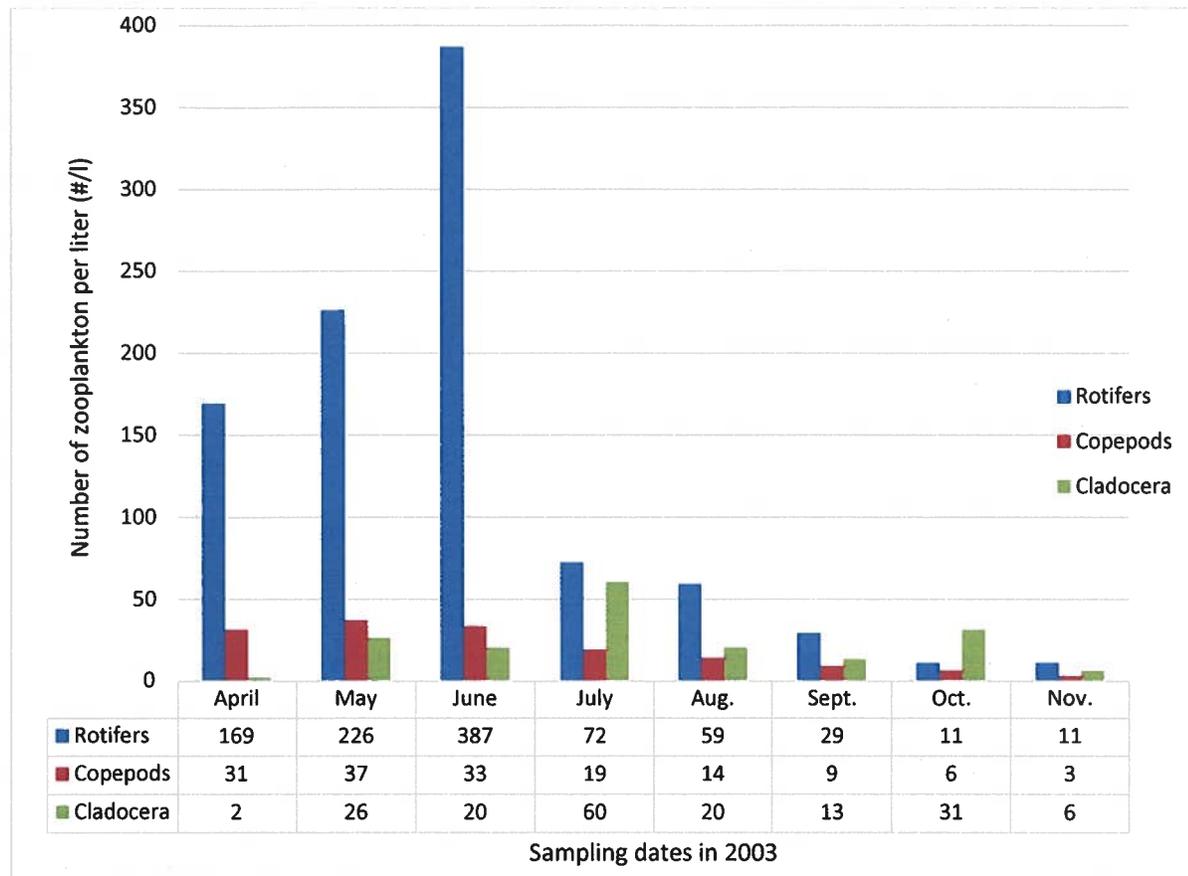


Figure 2. Number of zooplankton per tow in Woods Canyon Lake in 2003.

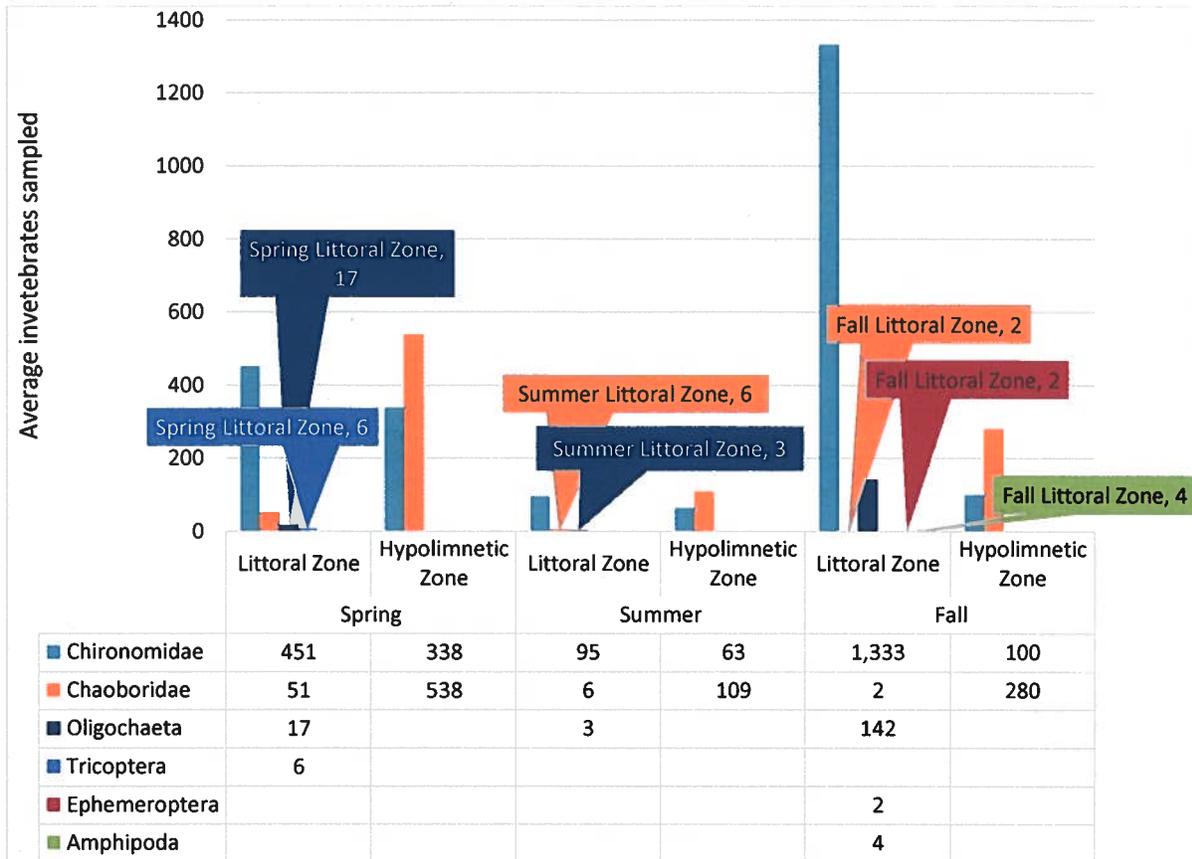


Figure 3. Number of benthos invertebrates in Woods Canyon Lake by season in 2003, stratified by littoral zone and hypolimnetic zone. Number is given as the mean number of invertebrates in all samples collected by ponar dredge in each zone.

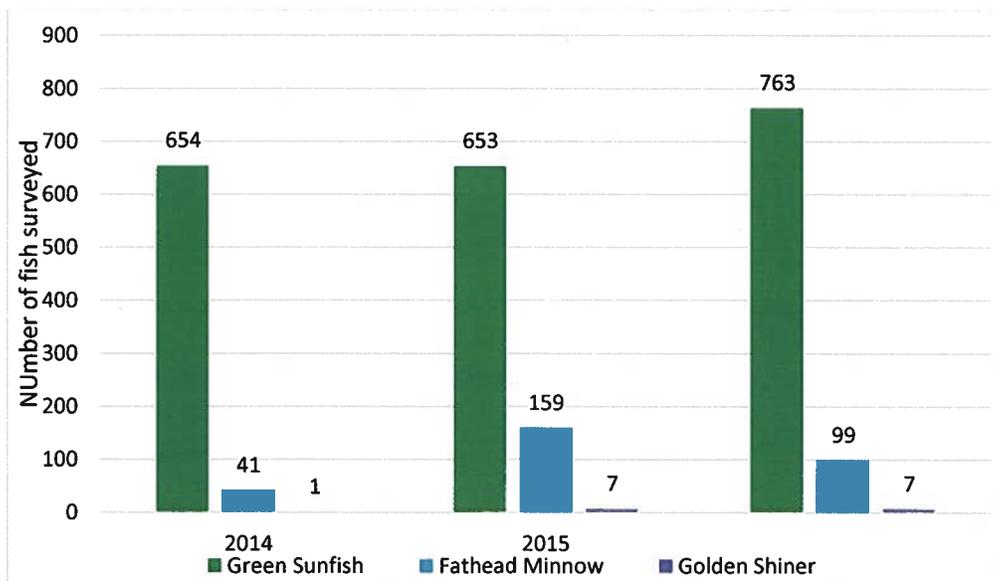


Figure 4. Boat electrofishing survey results from November 2014, September 2015 and October 2016 targeting illegally introduced warmwater species. Rainbow Trout and Tiger Trout were also surveyed.

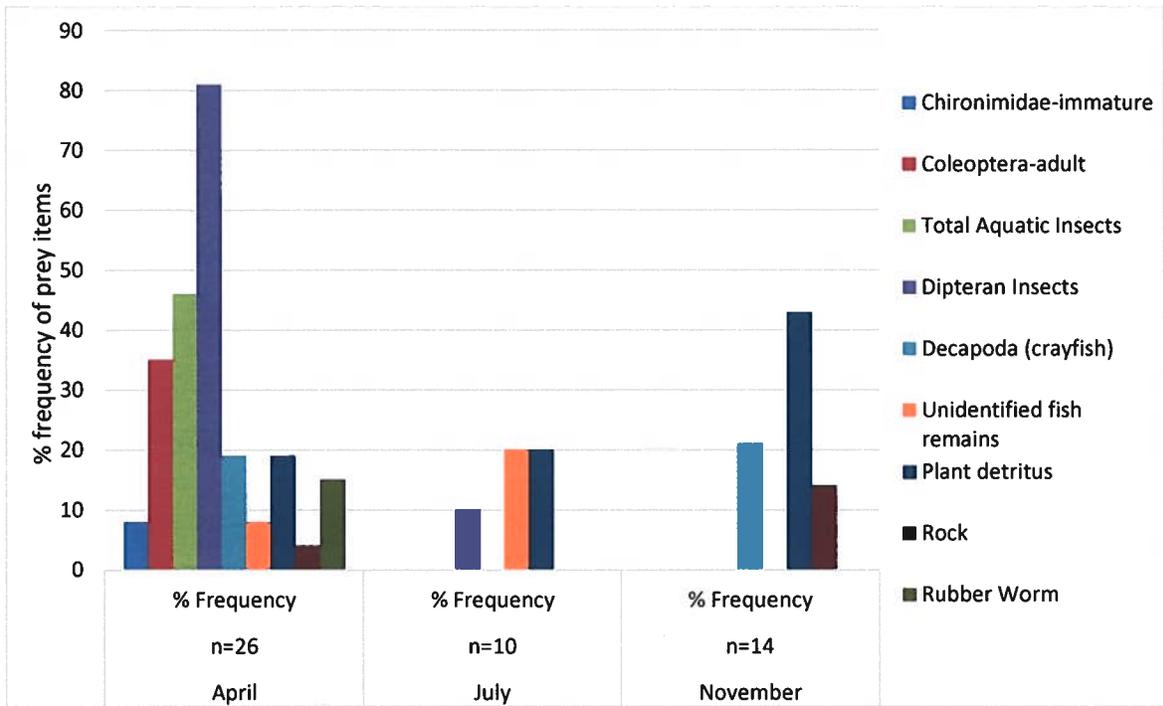


Figure 5. Percent frequency of prey items from stomach analysis of Rainbow Trout in Woods Canyon Lake by season in 2003. Percent frequency is shown as percent of trout stomachs containing that item. Some stomachs contained multiple items.

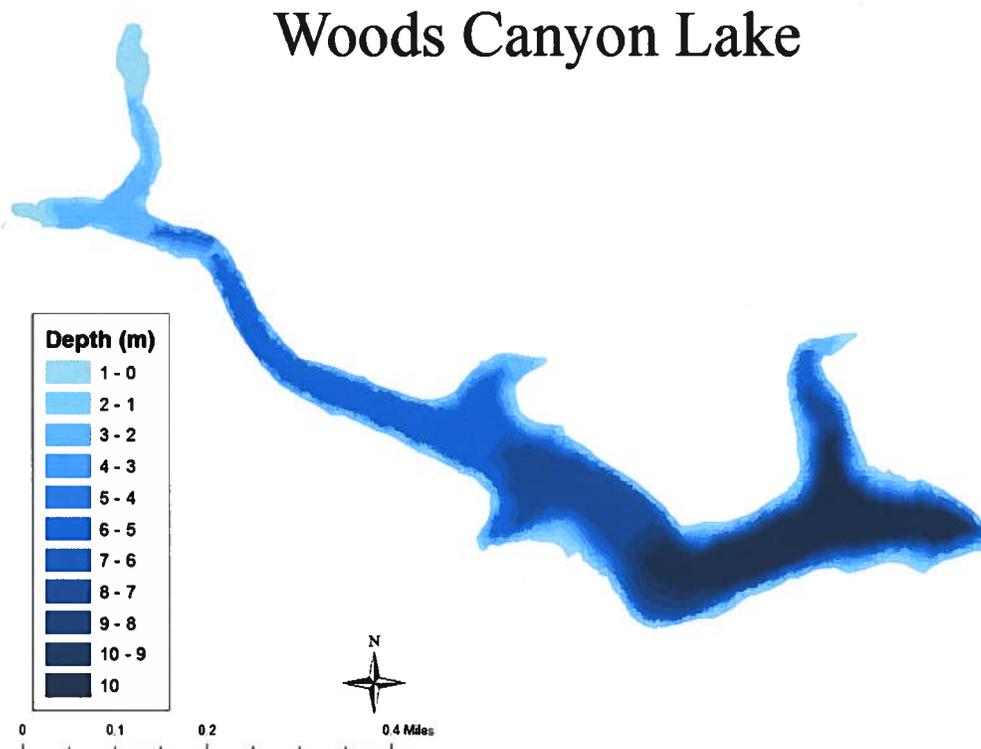


Figure 6. Bathymetric map of Woods Canyon Lake from 2015 survey.

Woods Canyon Lake

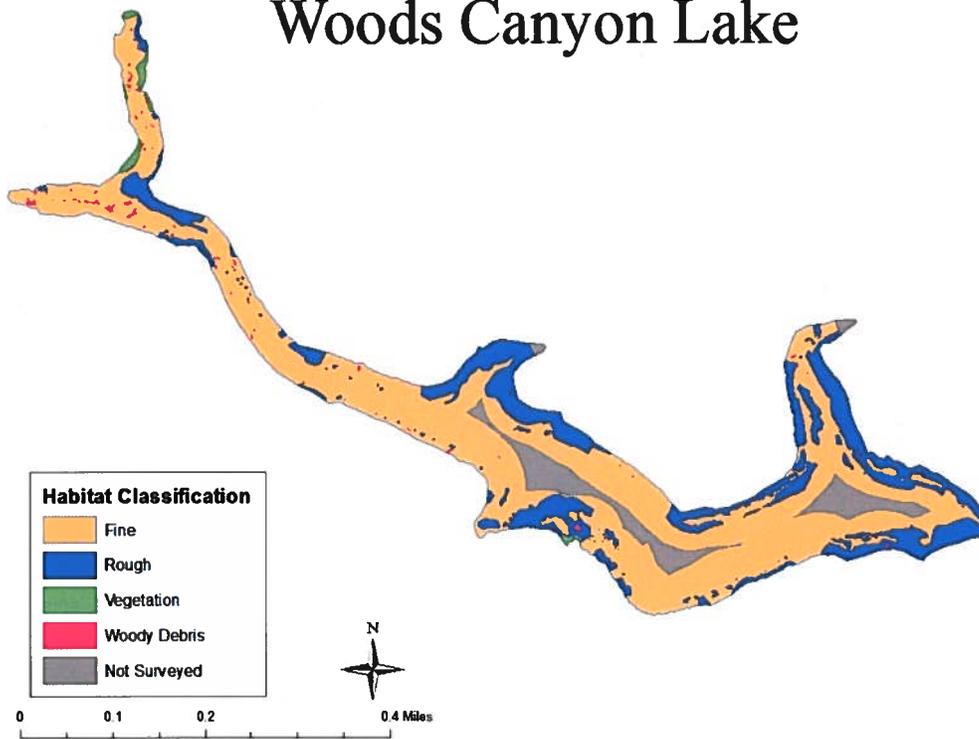


Figure 7. Aquatic habitat map of Woods Canyon Lake from 2015 survey.

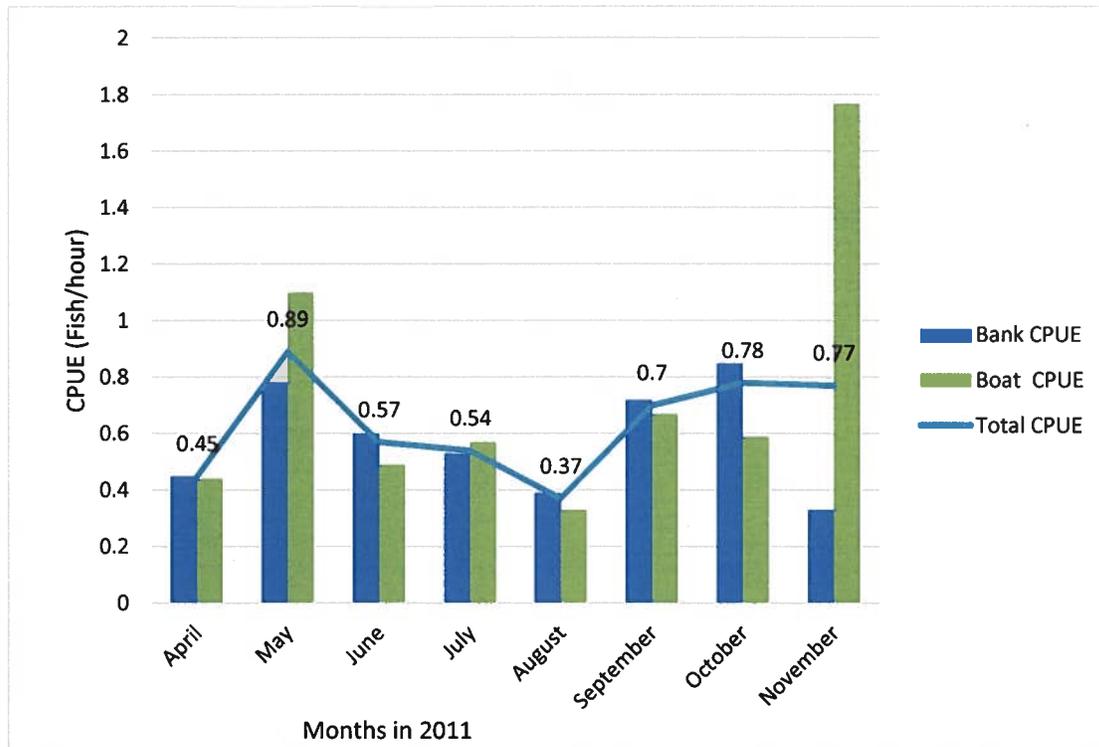


Figure 8. Angler catch rates (fish/hour) by month at Woods Canyon Lake in 2011.

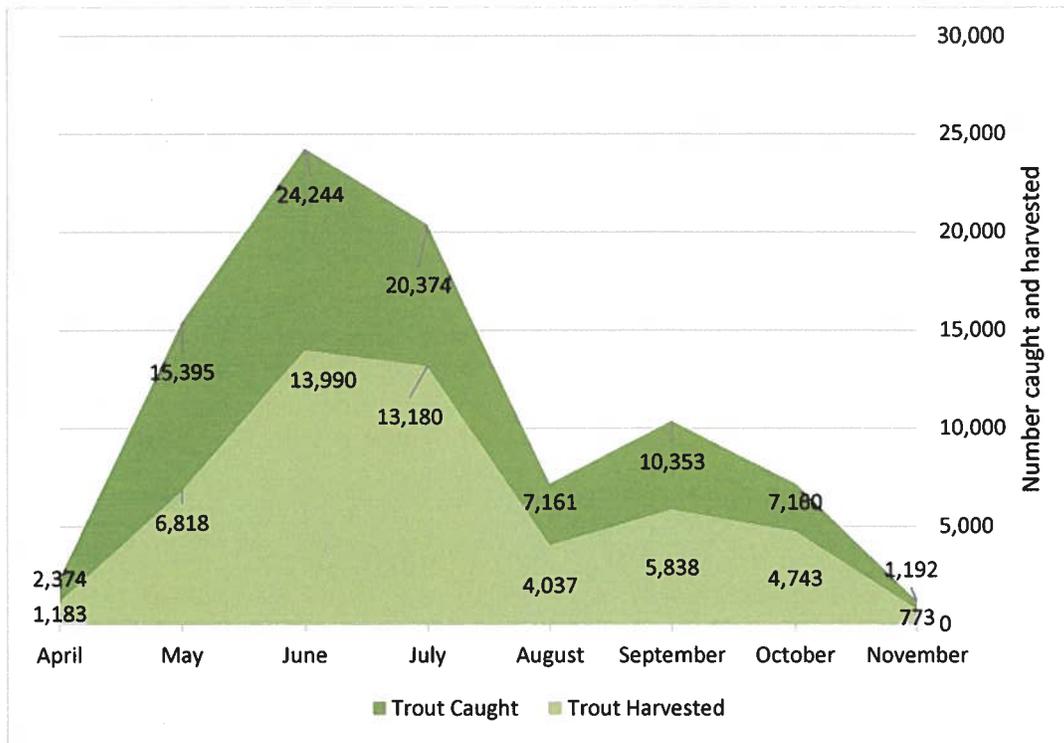


Figure 9. Rainbow Trout caught and harvested per month at Woods Canyon Lake in 2011.

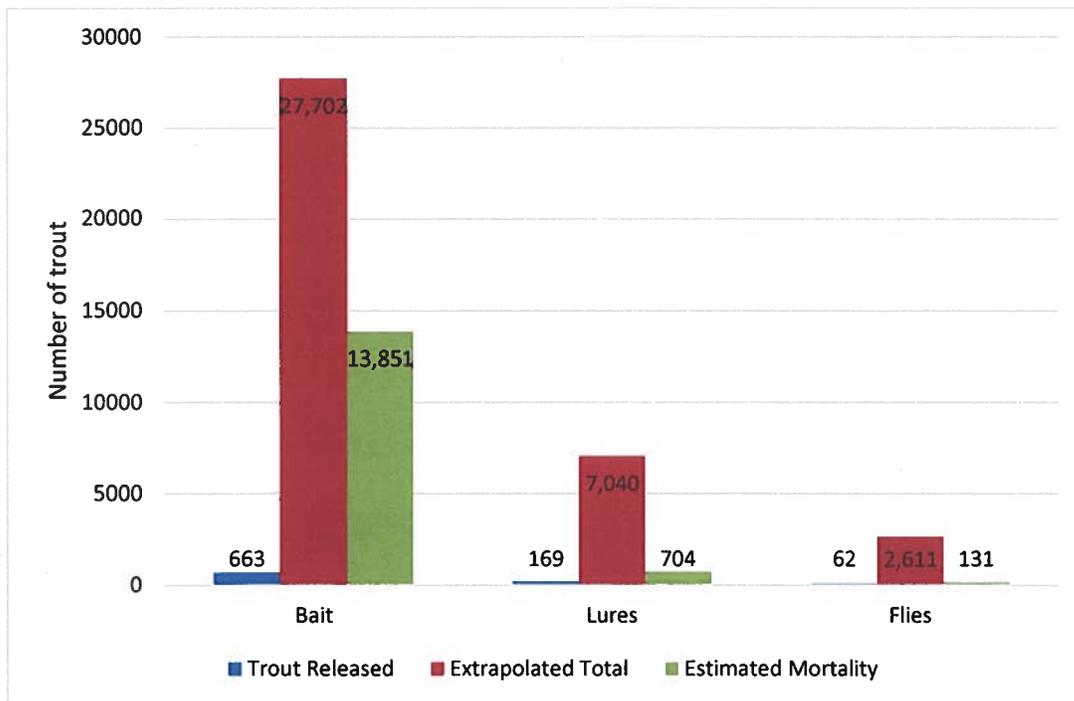


Figure 10. Trout released by fishing tackle and estimated mortality in Woods Canyon Lake in 2011. Numbers of trout released was determined by on-site angler creel surveys, extrapolated total is the estimated number of trout caught based on subsample creel data provides. Mortality rates are estimated to be 50% using bait, 10% using lures and 5% using flies.

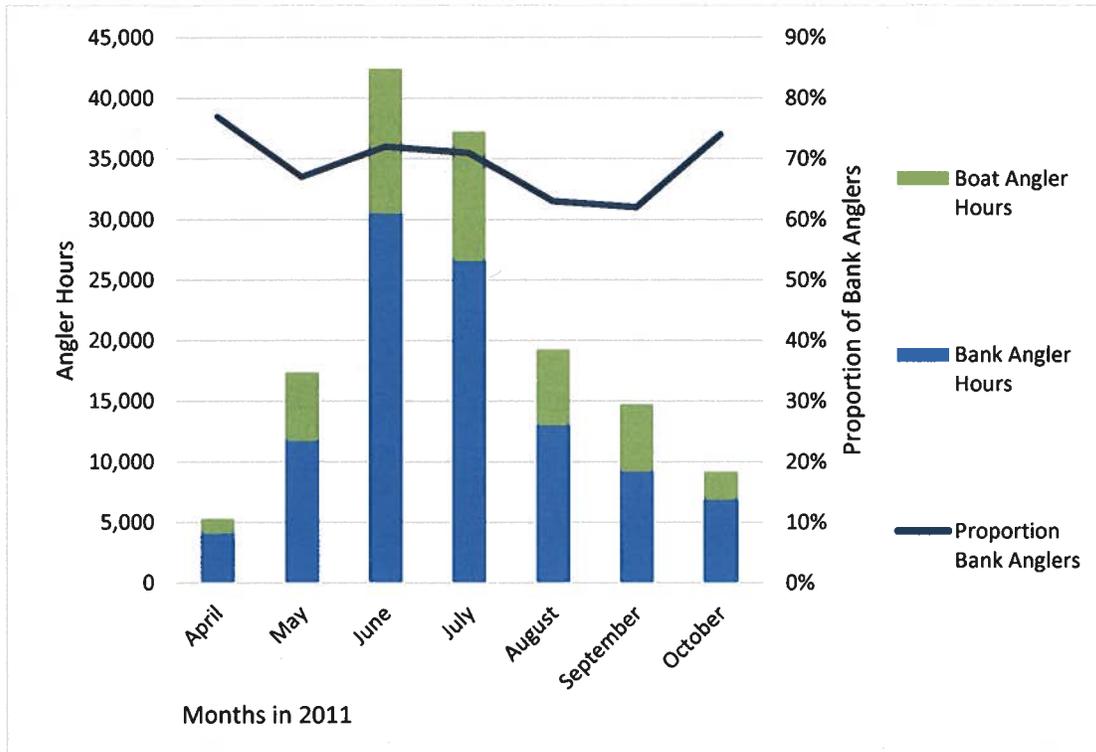


Figure 11. Angler use and proportion of bank anglers by month at Woods Canyon Lake in 2011.

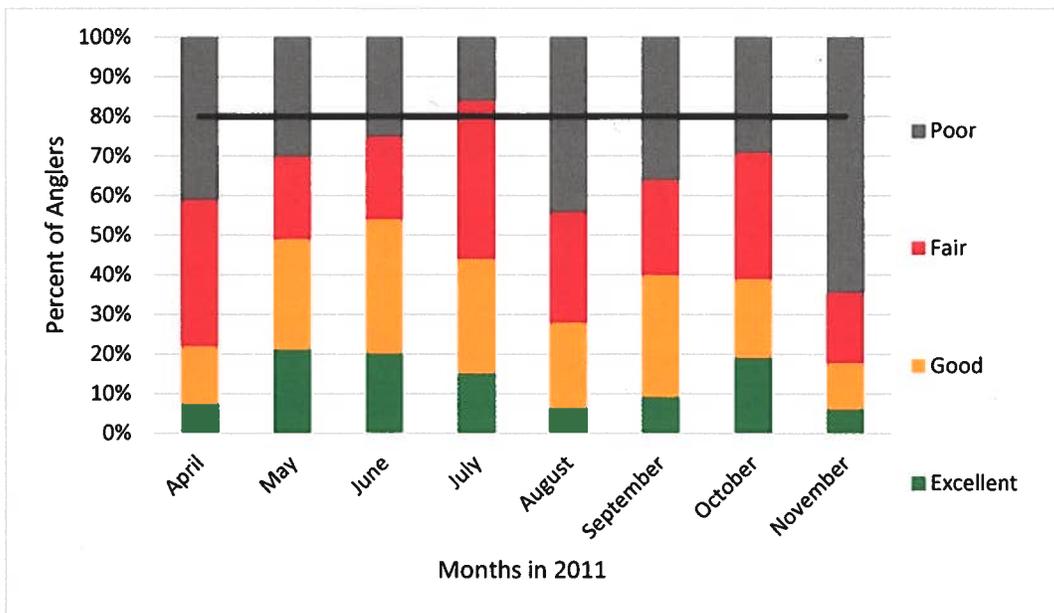


Figure 12. Satisfaction rates by month at Woods Canyon Lake in 2011. Numbers represent percent of anglers rating their angling experience as Poor, Fair, Good, or Excellent that month. The solid black line indicates the 80% goal for each month for the cumulative experience of Fair, Good and Excellent.